

Space Weather Technical Forecast

Issued on Friday, 04 February 2022 at 01:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-class flares (R1/R2 Radio Blackouts) throughout. Chance of isolated G1/Minor Storm activity, mainly tomorrow.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low with a number of C-class flares observed. Five numbered sunspot regions are spread across the visible disc, the largest of which is AR2936 in the northwestern quadrant with a complex Ehi/Beta-gamma classification. AR2939 (Dho/Beta) and AR2940 (Eai/Beta) both appear stable despite their relatively complex magnetic classifications. There is also AR2838, a small and simple Hsx/Alpha in the northwest quadrant. Two new regions have emerged through the past 24 hours, one a small and simple region which emerged in the southern hemisphere. The other new regions was numbered as AR2941, and is a potentially significant region; although analysis is currently hard to complete, due to the region's proximity to the northeast limb, it appears to be a large group with penumbra on the lead and trailing spots and is currently estimated to be Eki/alpha. No Earth directed CMEs were observed in the available imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, reflects the current influence of the CME which left the Sun on the 29th January. Solar winds have been at slightly elevated to elevated levels, peaking at 576 km/s at 03/1319 UTC. Density was average to slightly above average at first, then increased late morning to peak at 41 ppcc at 03/1059 UTC, after which the density remained above average. The strength of the magnetic field was moderate initially then became strong after 03/0430 UTC, peaking at 19 nT at 03/0920 UTC. After 03/1051 UTC the Bt declined to become predominantly weak. Bz was initially positive, but then a period of strongly negative Bz was observed from approximately 03/0700-0930 UTC. After this the Bz quickly became positive and then generally remained that way. The phi angle was positive (away from the Sun) with a change to negative (towards the Sun) from 03/0800 UTC, although later in the day some fluctuations did occur. Geomagnetic activity was initially Quiet but quickly increased. Early indications showed that G1/Minor Geomagnetic storm levels were reached, but subsequent data from the British Geological Society showed that in fact G2/Moderate geomagnetic storm levels (Kp 6) were reached 03/0600-1200 UTC, with unsettled to active (Kp 3-4) conditions following for the rest of the day.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), diurnally fluctuated between background and moderate levels, with a peak value of 371 pfu at 03/2030 UTC. The associated 24-hour electron fluence was steady for much of the day, well below the Active threshold (1e8 integrated pfu), then decreased late in the day, with a value of 7.21e6 integrated pfu at 04/0000 UTC.

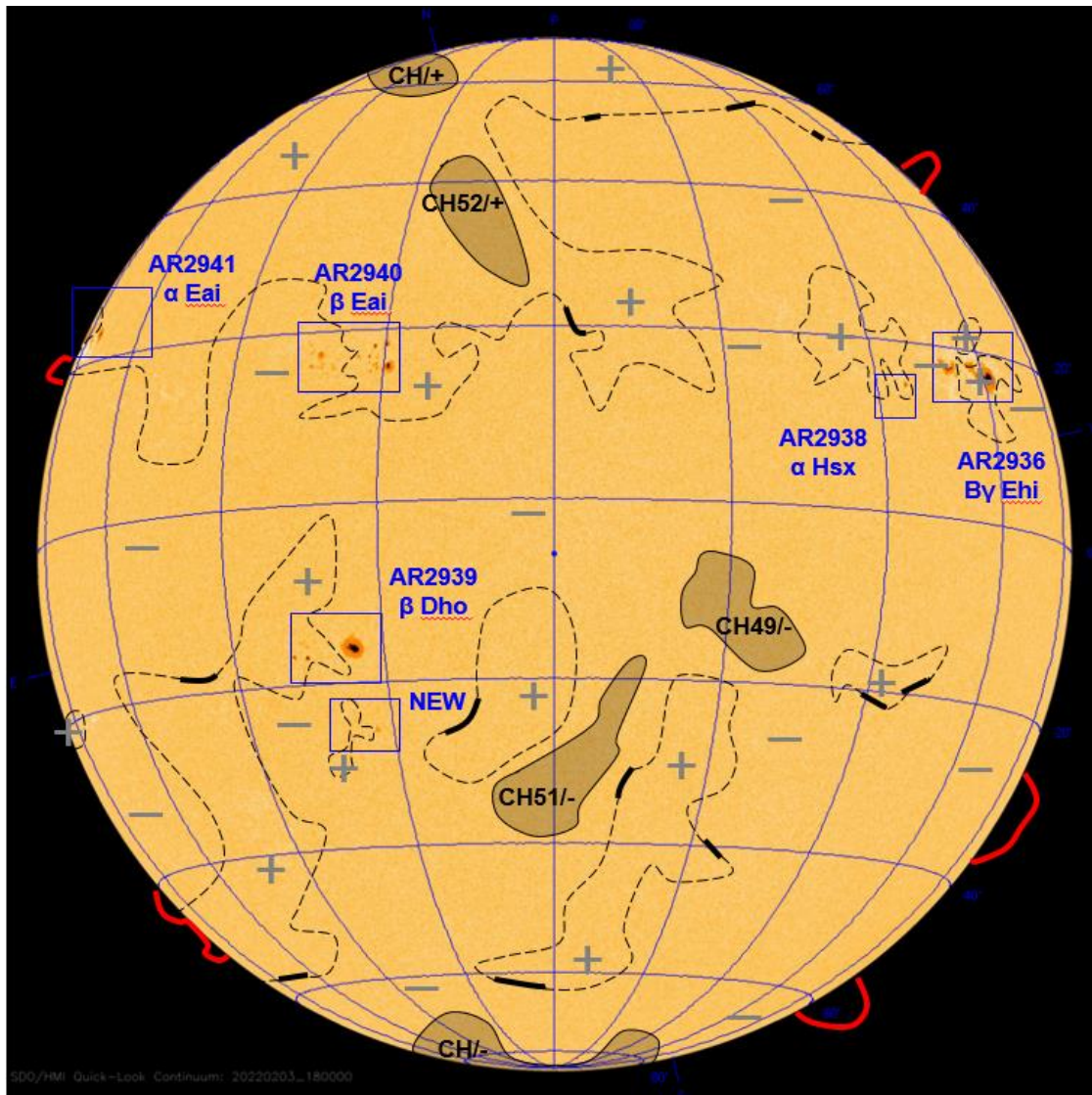
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low, with further C-class flares, a chance (30%) of M-class flares and a slight chance (5%) of an X-class flare.

Solar Wind / Geomagnetic Activity: Solar winds will probably remain elevated for much of today, with a chance of briefly becoming strong. Tomorrow (5th) the solar wind may temporarily decrease to slightly elevated levels, before returning to elevated levels as a high speed stream (HSS) from CH49 becomes geoeffective. This is most likely to occur tomorrow morning. Through day 3 (6th) the solar wind is expected to gradually decline to slightly elevated levels, then possibly down to background levels by late day 4 (7th). Quiet to Unsettled (Kp 1-3) geomagnetic activity is expected throughout, with occasional Active (Kp 4) intervals today, tomorrow and day 3 (6th). There is also a chance (30%) of a G1/Minor Storm interval today and also day 3 (20%), but especially tomorrow (50%) in association with the arrival of the HSS.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background to moderate levels but with a slight chance of rising close to or just above the S1 level given any significant M-class flaring. The high energy electron flux (greater than 2MeV) is likely to remain at background to moderate levels, but may become High ($>1e3$ pfu) during diurnal peaks. The electron fluence is likely to remain below the Active ($1e8$ integrated pfu) threshold, but with a generally rising trend forecast over the next four days.

Figure 1. Solar Analysis Valid 03/1800 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A full halo CME from the 29th January arrived at Earth late on the 1st February and Earth probably continues to be affected by the associated magnetic cloud. Solar winds are currently elevated from this feature and will probably remain elevated for much of today, with a chance of briefly becoming strong. Tomorrow (5th) the solar wind may temporarily decrease to slightly elevated levels, before returning to elevated levels as a high speed stream (HSS) from CH49 becomes geoeffective. This is most likely to occur tomorrow morning. Through day 3 (6th) the solar wind is expected to gradually decline to slightly elevated levels, then possibly down to background levels by late day 4 (7th).

Quiet to Unsettled (Kp 1-3) geomagnetic activity is expected throughout, with occasional Active (Kp 4) intervals today, tomorrow and day 3 (6th). There is also a chance (30%) of a G1/Minor Storm interval today and day 3 (20%), but especially tomorrow (50%) in association with the arrival of the co-rotating interaction region (CIR) and high speed stream (HSS) from CH49.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	30	50	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X-Ray Flares:

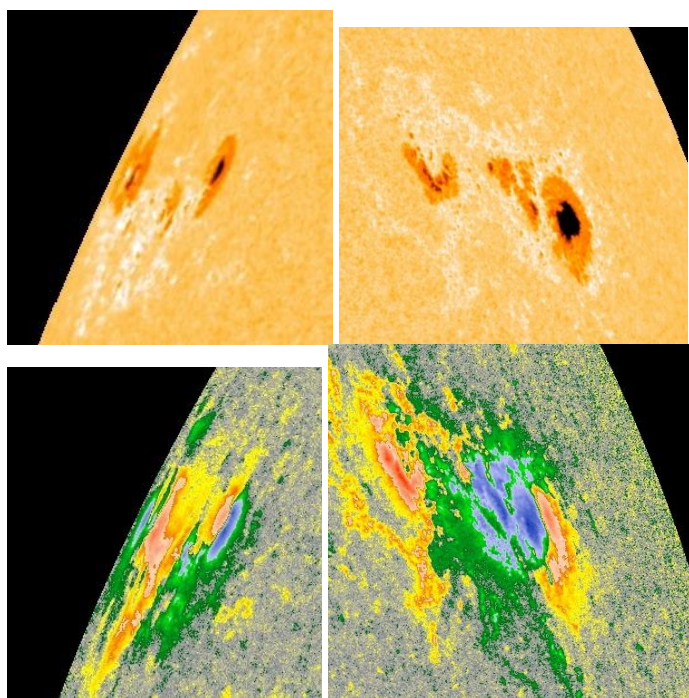
Solar activity has been Low over the past 24 hours, with numerous low level C-class flares. There are five numbered regions on the visible disc, with AR2936 and AR2941 the most likely to generate significant flares. AR2941 is still currently close to the northeast limb, and so hard to analyse, but is estimated to be Eki/alpha although it is likely to be more geomagetically complex. AR2936 is classified as Ehi/beat-gamma, but despite this has only recently generated C-class flares. Further regions may rotate on from the farside through the next 24 hours.

Solar activity is expected to remain predominantly Low through the forecast period, with further C-class flares, a chance (30%) of M-class flares and a slight chance (5%) of an X-class flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
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Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: SDO AIA Intensitygram flattened (above) and SDO AIA magnetogram (below) showing AR2941 (left) and AR2936 (right).



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not likely in the period, however there is a slight chance (5%) for proton fluxes to rise given any significant flaring, predominately from AR2936 positioned in the northwest quadrant.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux (greater than 2MeV) is currently at moderate to background levels, but may rise to High ($1\text{e}3 \text{ pfu}$) levels during its diurnal peak, in response to the current elevated solar winds, especially during days 3 and 4 (6th and 7th). Before this a reduction in the high energy electron flux is likely to occur, as a result of increased geomagnetic activity at times today but especially tomorrow (5th).

The corresponding electron fluence is expected to exhibit a rising trend from day 3 (6th) but the Active threshold ($1\text{e}8 \text{ integrated pfu}$) is unlikely to be breached. The Met Office REFM model is considered to be offering reasonable guidance, but with the increasing trend delayed to that shown, and with the Active threshold unlikely to be breached during day 3.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1\text{e}8$	No	10	10	20	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1\text{e}9$	No	1	1	1	1

Figure 3: Met Office REFM model.

